Orbiting Wide-angle Light-collectors (OWL)

Electrical Design Estimates

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OWL Functional Block Diagram

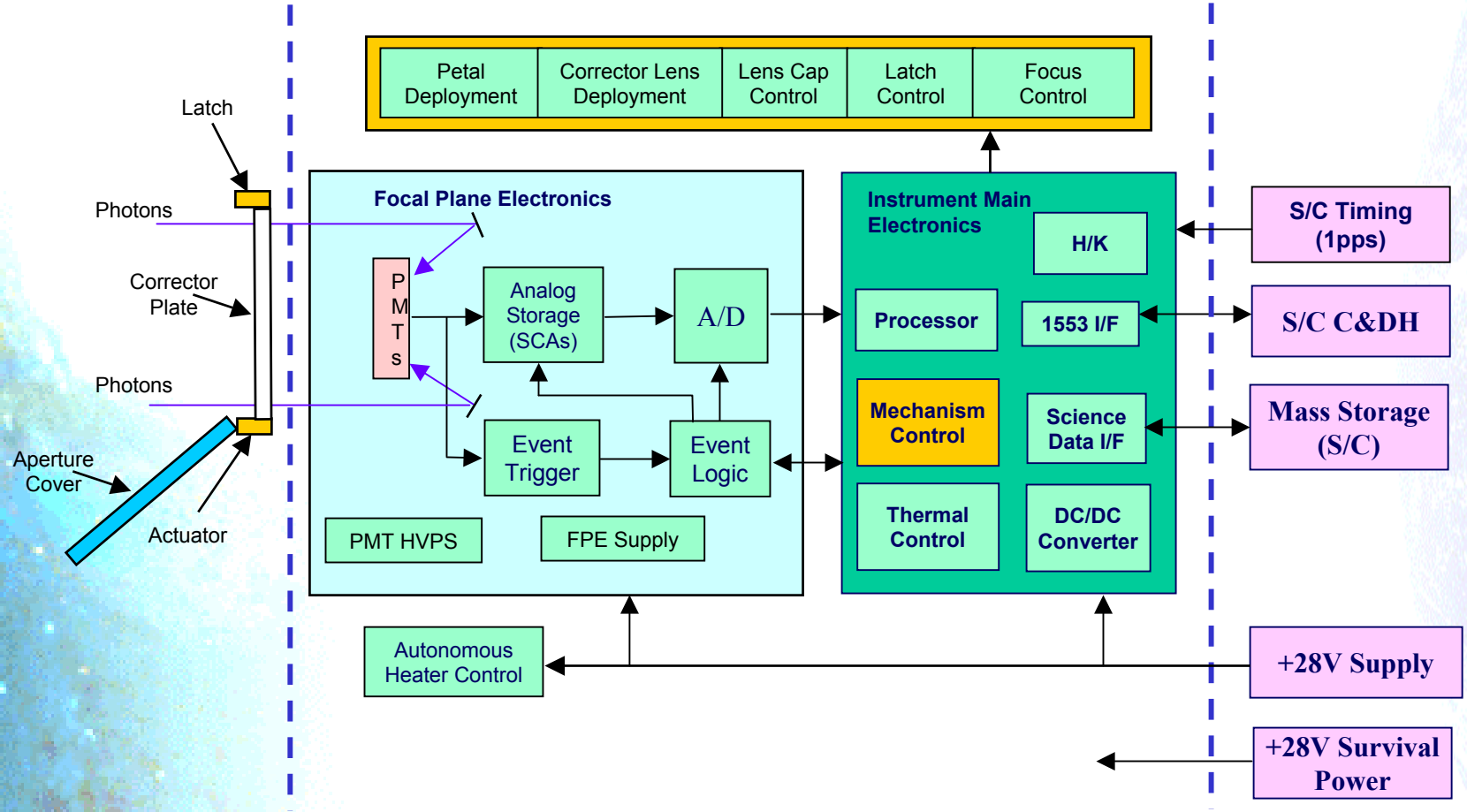
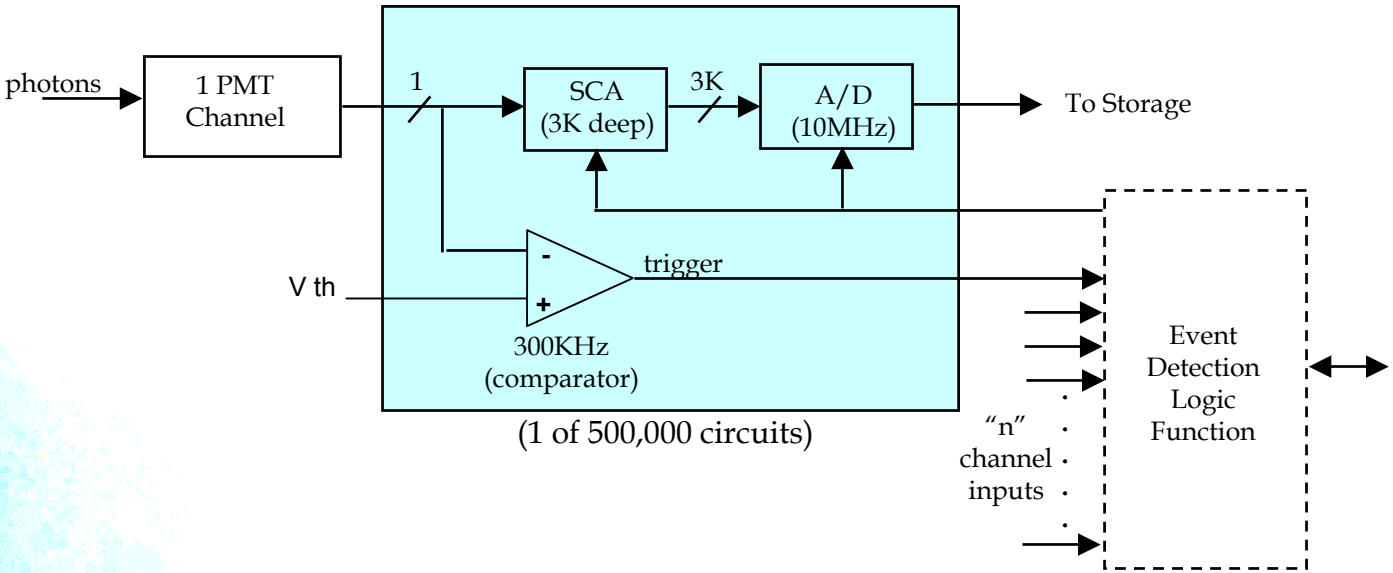


Figure 1.

Focal Plane Assembly

Electronics Design



Key:

PMT - PhotoMultiplier Tube

SCA - Switched Capacitor Array

Figure 2.

Data Rates

Data Acquisition Rate:

Assume SCA Readout @ 10MHz & 12-bits per A/D sample

⇒ Readout Rate ~ (10M Samples/sec) x (12-bits/sample)
~ 120Mbps per SCA

⇒Readout Time for 10 cells ~ (10/10MHz) ~ 1uSec per SCA

Assume Readout of 20,000 SCAs per event

⇒ Data Quantity ~ (10 cell x 12-bits x 20,000 SCAs) ~ 2.4 Mbits

Focal Plane Assembly

Electronic Packaging

- ~ 400 channels per PMT (1 channel => 1pixel)
- ~ 6cm x 6cm square per PMT
- 0.3" x 0.3" for 400 event detection circuits
- Assuming each capacitor is (100 x 100)microns,
  => 1,200K capacitors (ie. 400 X 3K) requires an area
  ~ 10cm x 10cm (or ~ Four squares of 6cm x 6cm)

Also;

- ~ 539,000 total channels
- =>1,348 PMTs (ie. 539K/400)

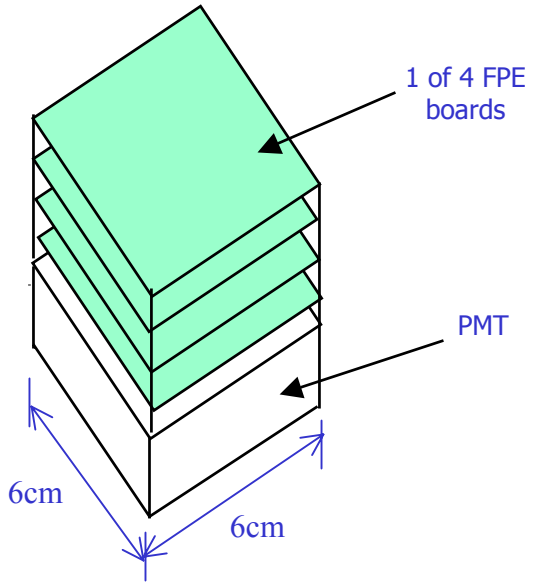
FPE Power Estimate

0.25mW per SCA => 125Watts

2.5uW per event detection & logic circuit ~ 1.25Watts

Focal Plane Assembly

- 100 SCAs for each FPE board
  => 400 SCAs per PMT



(One unit of assembly shown out of 1,348 need to populate the entire focal plane)

Figure 3.

Circuit Board Functional Allocation

Main Electronics Box

- Processor Board (1)
- Mechanism Control Board (4)
- Housekeeping Board (1)
- Thermal Control (1)
- Power Board (1)

Processor Board

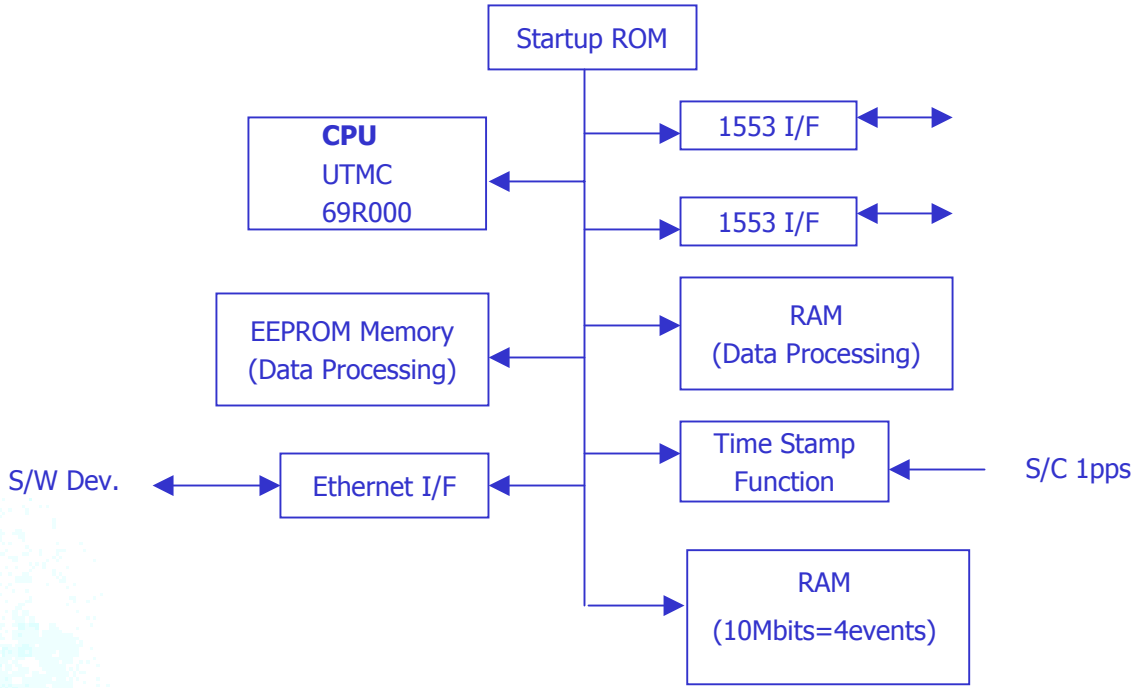
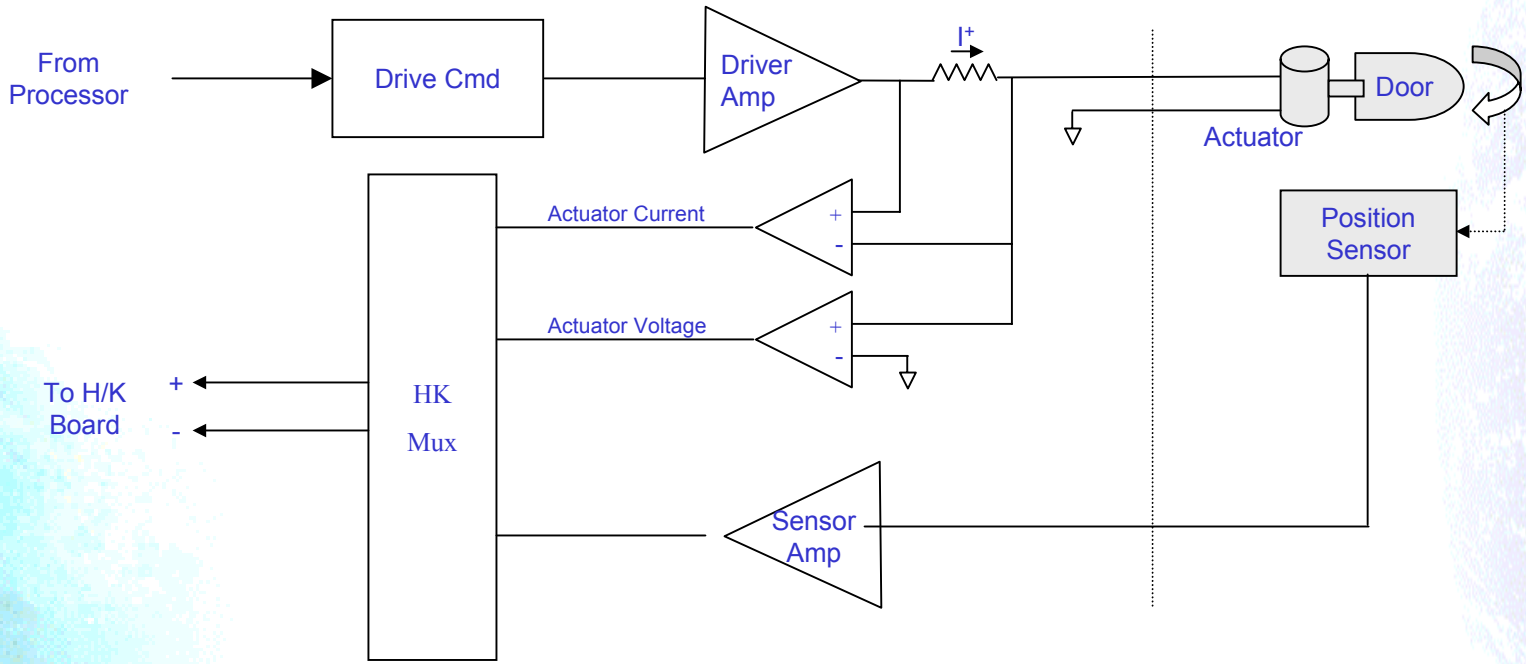


Figure 4.

Mechanism Control Board

- Inflatable Shield Deployment
  - 12 Valves, 12 Guages, 36 Valve Position Sensors
- Petal Deployment
  - 8 Drive Motors, 8 Motorized Latches, 8 Position Sensors
  - 12 Petal Release Actuators
- Corrector Plate Deployment
  - 4 Actuators, 4 Drive Motors, 4 Position Sensors
- Aperture Cover
  - 1 Actuator, 1 Motorized Latch, 1 Position Sensors
- Focus Mechanism
  - 24 Focus actuators

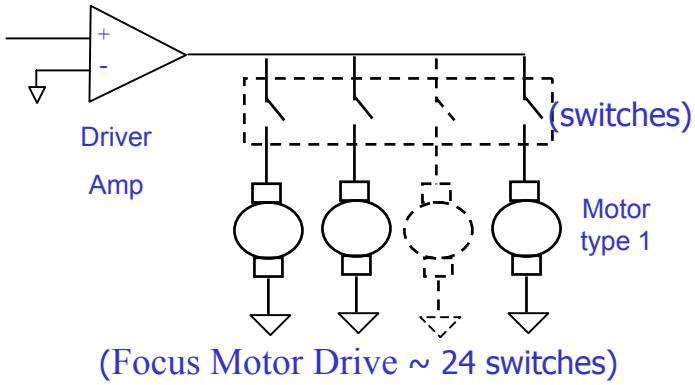
Mechanism Control Board



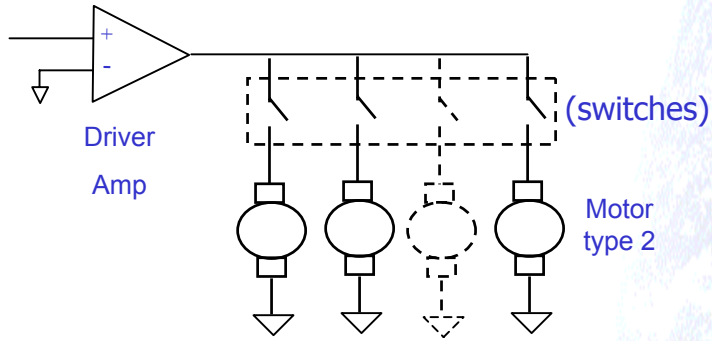
(1 of 4 circuits, 1 circuit per motor type)

Figure 5.

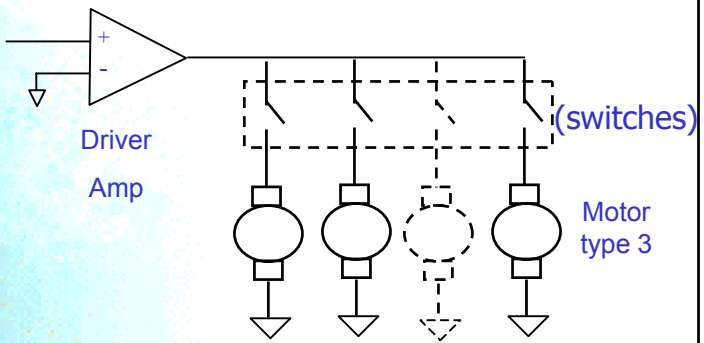
Mechanism Control Boards (4)



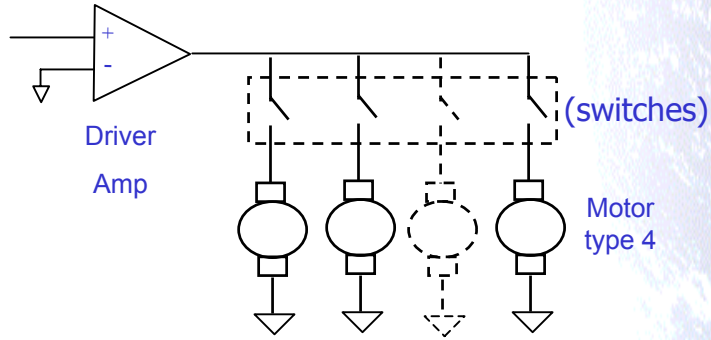
(Focus Motor Drive ~ 24 switches)



(Petal Latch & Corrector Motors ~ 21 switches)



(Lens Cap Motor Drive ~ 1 switch)



(Valve Motor Drive ~ 1 switch)

Figure 6.

HouseKeeping Board

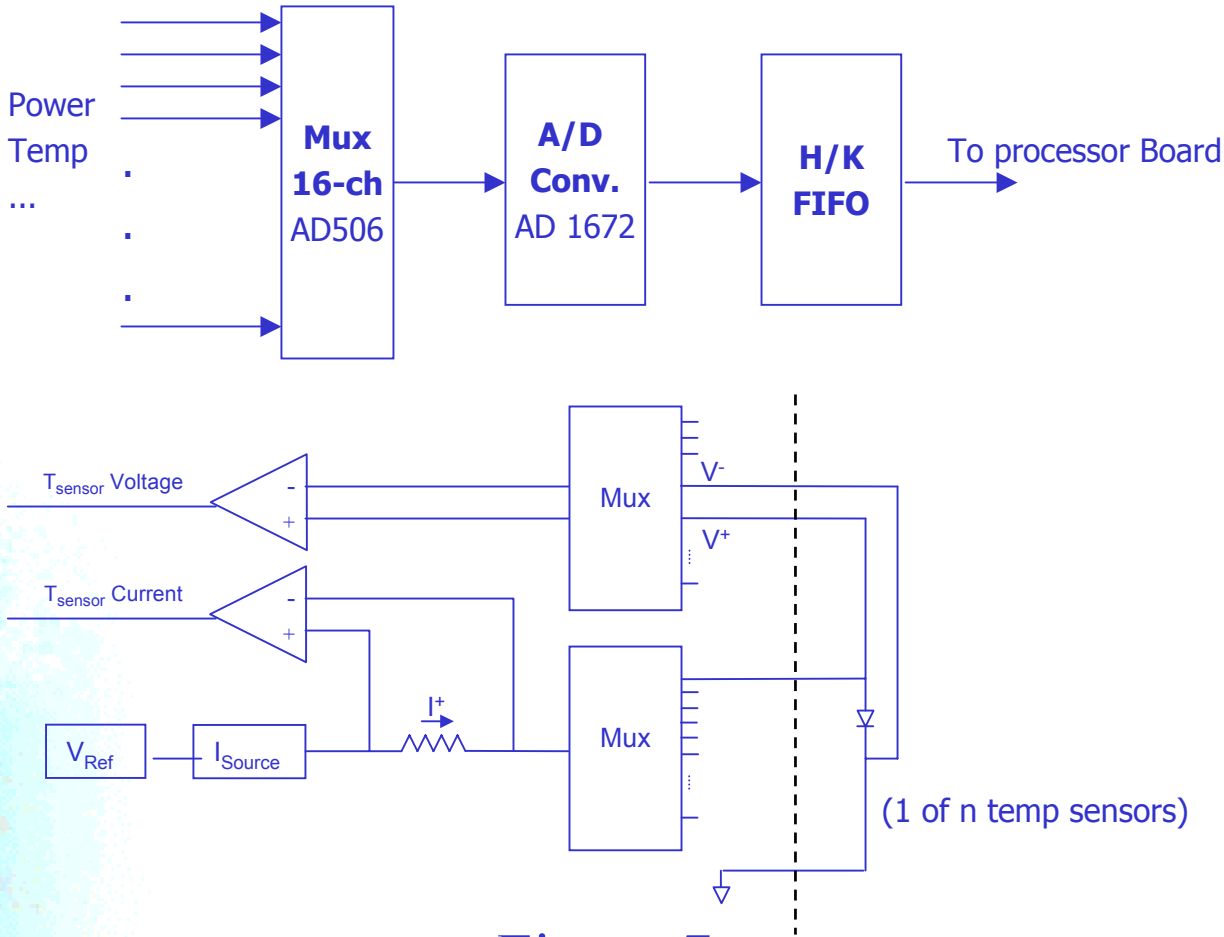
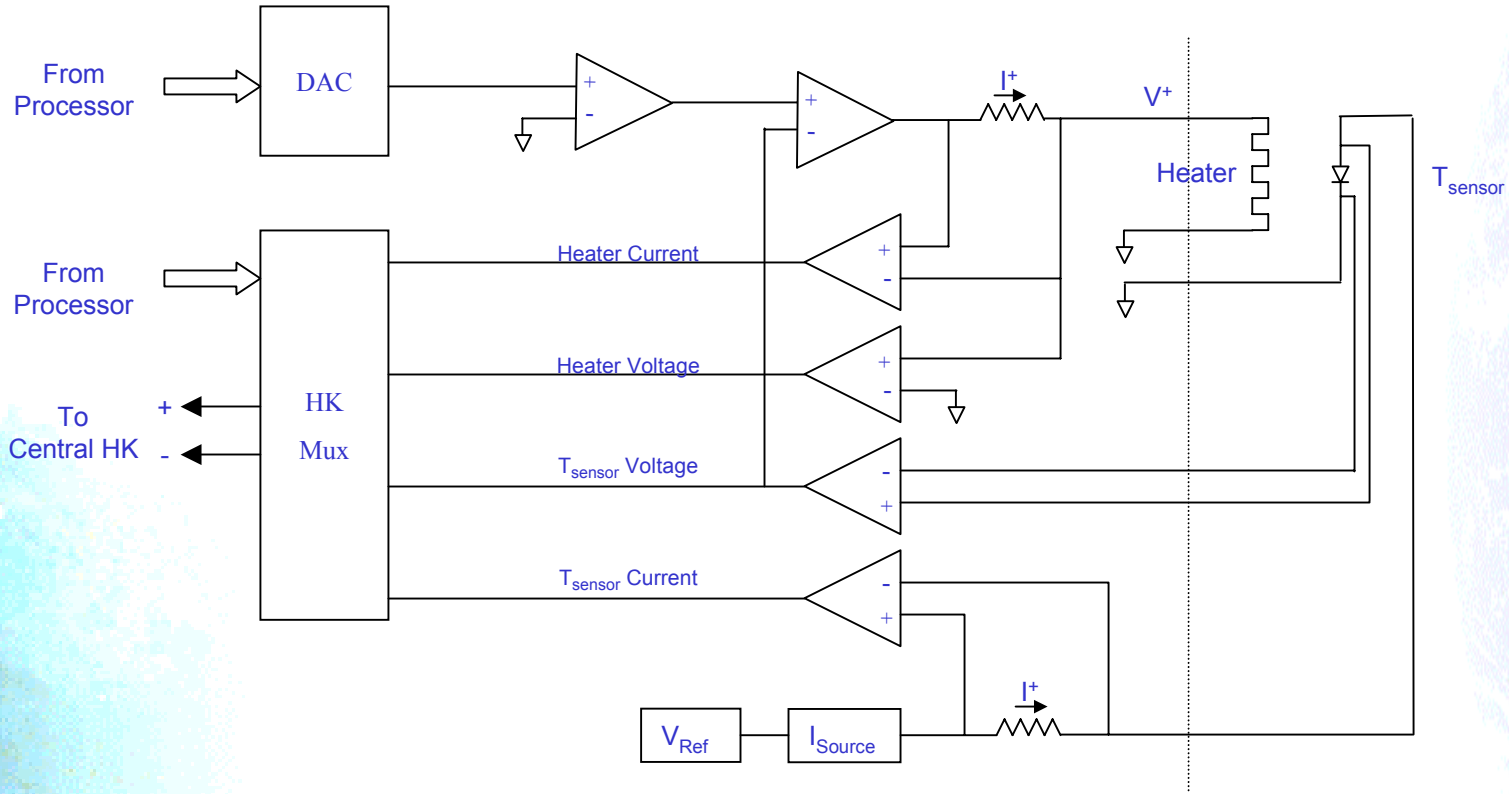


Figure 7.

Thermal Control Board



(1 of 6 circuits shown)

Figure 8.

Main Electronics Power Board

Main Electronic Box Boards	Avg. Power
Processor Board	4 Watts
Mechanism Control Board (4) (assume 2 boards on)	0 Watts (8 Watts)
HouseKeeping Board	3 Watts
Thermal Control Board	3 Watts
Power Board	4.3 Watts (7.7 Watts)
Box Total:	14.3 Watts (25.7 Watts)

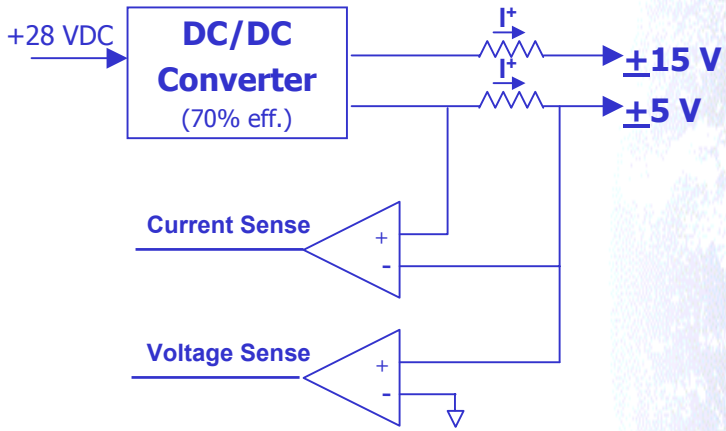
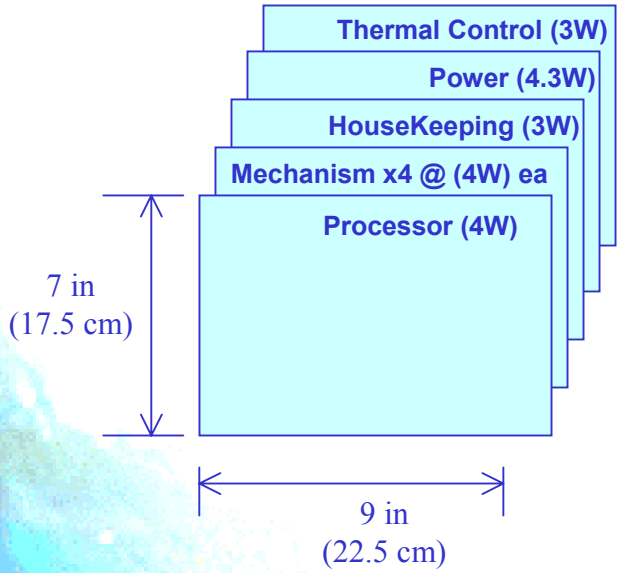


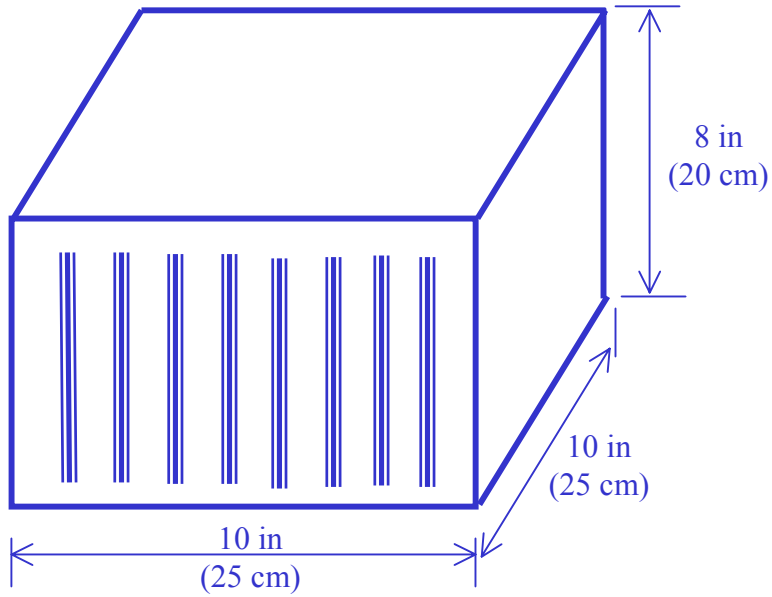
Figure 9.

Main Electronics Box Summary



Total: ~ 20 Watts (avg.)

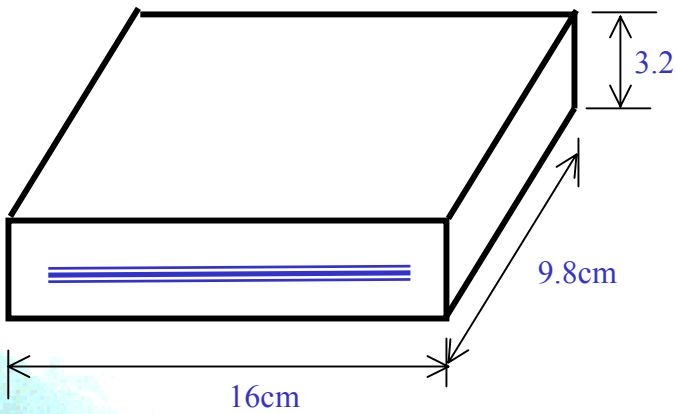
Main Electronics Box



Estimated Mass ~ 7 Kg
Estimated Power ~ 14.3 Watts (Avg.)
Estimated Size ~ (20 x 25 x 25) cm.

Figure 10.

High Voltage Power Supply



HVPS (+1,000V & +2,000V)

- OWL needs 14 small boxes; estimate based on BERTRAN a Design.

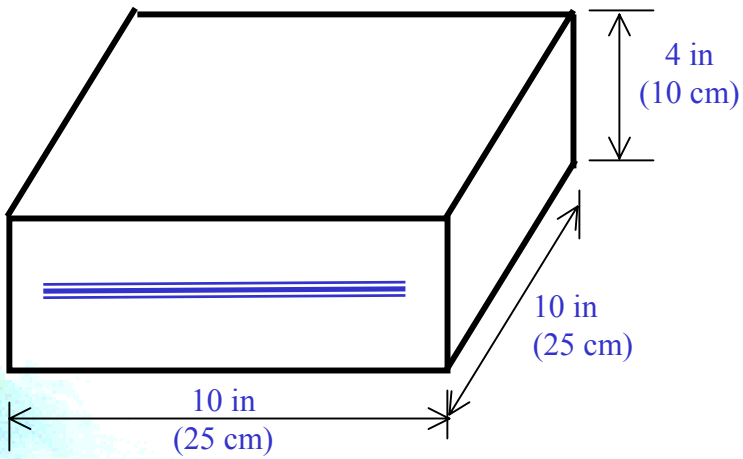
Where;
Each Box delivers ~ 15.7 Watts total for a cluster of 96 PMTs.

Each Box dissipates ~ 6.7 Watts (assuming ~ 70% efficiency)

Estimated Mass ~ 0.9 Kg
Estimated Power ~ 6.7 Watts (Avg.)
Estimated Size ~ (98 x 16 x 3.2) cm.

Figure 11.

FPE Power Supply



FPE Power Supply (±0.5V, ±5V, ±15V)

1 board (9" x 9") capable of supplying ~ 130 Watts, and dissipates ~ 55 Watts (assuming ~ 70% efficiency)

Estimated Mass ~ 5 Kg
Estimated Power ~ 55 Watts (Avg.)
Estimated Size ~ (10 x 25 x 25) cm.

Figure 12.

Conclusion

- Refinement of the logic (or methodology) to determine the number of SCAs and the number of cells per SCA to be read out will improve the accuracy of the data accumulation and storage requirements prediction.
- Also, better accuracy in estimating the physical size of the 3,000 cell SCAs will improve the packaging estimate of the Focal Plane Electronics.
- Significant Focal Plane power reduction was predicted for the digital circuits by utilizing GSFC's Ultra Low Power technology (ref: Pen-Shu Yeh).